US008617060B2

(12) **United States Patent**
Masaki et al.

(10) **Patent No.: US 8,617,060 B2**
(45) **Date of Patent: Dec. 31, 2013**

(54) **ENDOSCOPE LIGHT SOURCE APPARATUS AND ENDOSCOPE SYSTEM**

(71) Applicant: **Olympus Medical Systems Corp.**, Tokyo (JP)

(72) Inventors: **Takahiro Masaki**, Kawasaki (JP); **Kyosuke Mizuno**, Hachioji (JP); **Rihito Ishikawa**, Hino (JP); **Tomoya Takahashi**, Hachioji (JP)

(73) Assignee: **Olympus Medical Systems Corp.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/652,796**

(22) Filed: **Oct. 16, 2012**

(65) **Prior Publication Data**

US 2013/0109921 A1 May 2, 2013

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2011/065983, filed on Jul. 13, 2011.

(30) **Foreign Application Priority Data**

Jul. 14, 2010 (JP) 2010-159953

(51) **Int. Cl.**
A61B 1/06 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 1/0646*** (2013.01); *A61B 1/0669* (2013.01)
USPC **600/181**; 600/178; 362/574

(58) **Field of Classification Search**
CPC ... A61B 1/0061; A61B 1/0669; A61B 1/0646
USPC 600/178, 181; 362/574, 280, 282
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,924,856	A	5/1990	Noguchi	
4,983,019	A	1/1991	Ikuno et al.	
5,007,408	A	4/1991	Ieoka	
7,070,560	B2 *	7/2006	Takahashi	600/178
8,066,409	B2 *	11/2011	Toriyama et al.	362/293

(Continued)

FOREIGN PATENT DOCUMENTS

EP	2 301 420	A1	3/2011
JP	01-170436		7/1989

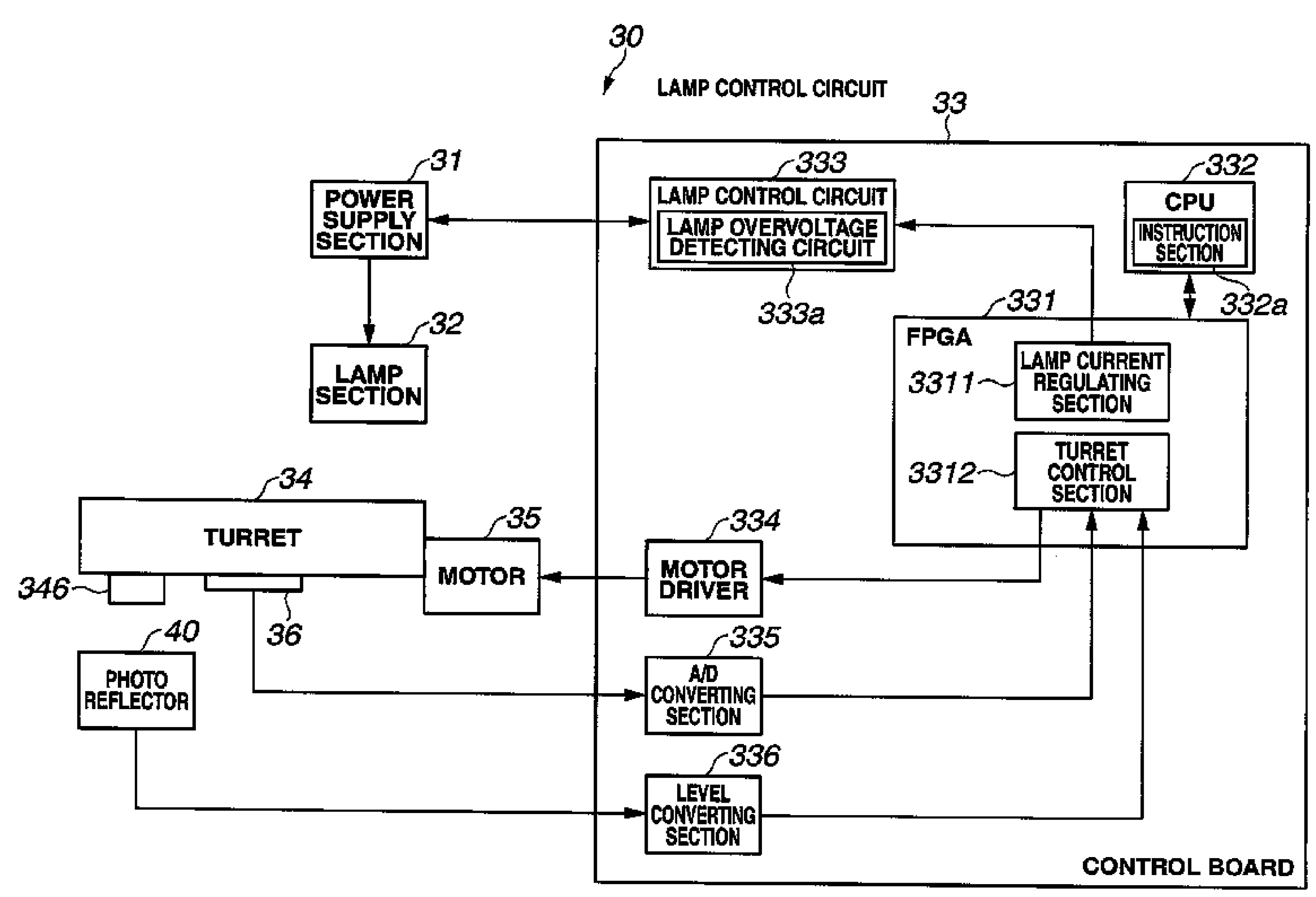
(Continued)

Primary Examiner — John P Leubecker
(74) *Attorney, Agent, or Firm* — Scully, Scott, Murphy & Presser, P.C.

(57) **ABSTRACT**

An endoscope light source apparatus includes a turret provided with a first optical filter and a second optical filter for transmitting an illuminating light, an instruction section in which an operation instruction of the turret is inputted, a drive section that drives the turret, a first detector that detects a position of the turret, a first detected portion for identifying a position of the first optical filter, a second detected portion for identifying a position of the second optical filter, a second detector that optically detects a position of the first or the second detected portion, and a turret control section that outputs a drive signal to the drive section to move the turret until the first or the second detected portion is detected by the second detector and stop the turret in response to the first or the second detected portion being detected.

6 Claims, 9 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

8,167,796	B2 *	5/2012	Negishi	600/181
2007/0010714	A1 *	1/2007	Negishi	600/180
2007/0100205	A1 *	5/2007	Iriyama	600/118
2007/0263406	A1 *	11/2007	Negishi	362/574
2009/0290374	A1 *	11/2009	Tashiro et al.	362/574

FOREIGN PATENT DOCUMENTS

JP	01-217414	8/1989
JP	02-020816	1/1990
JP	03-021219	1/1991
JP	08-107879	4/1996
JP	09-197294	7/1997
JP	2001-343595	12/2001
JP	2002-153422	5/2002
JP	2004-261227	9/2004
JP	2007-014451	1/2007
JP	2007-190180	8/2007
JP	2007-229135	9/2007
JP	2008-029740	2/2008
JP	2009-189495	8/2009
JP	2009-297436	12/2009
WO	WO 2004/073509 A1	9/2004
WO	WO 2009/154028 A1	12/2009

* cited by examiner

FIG.1

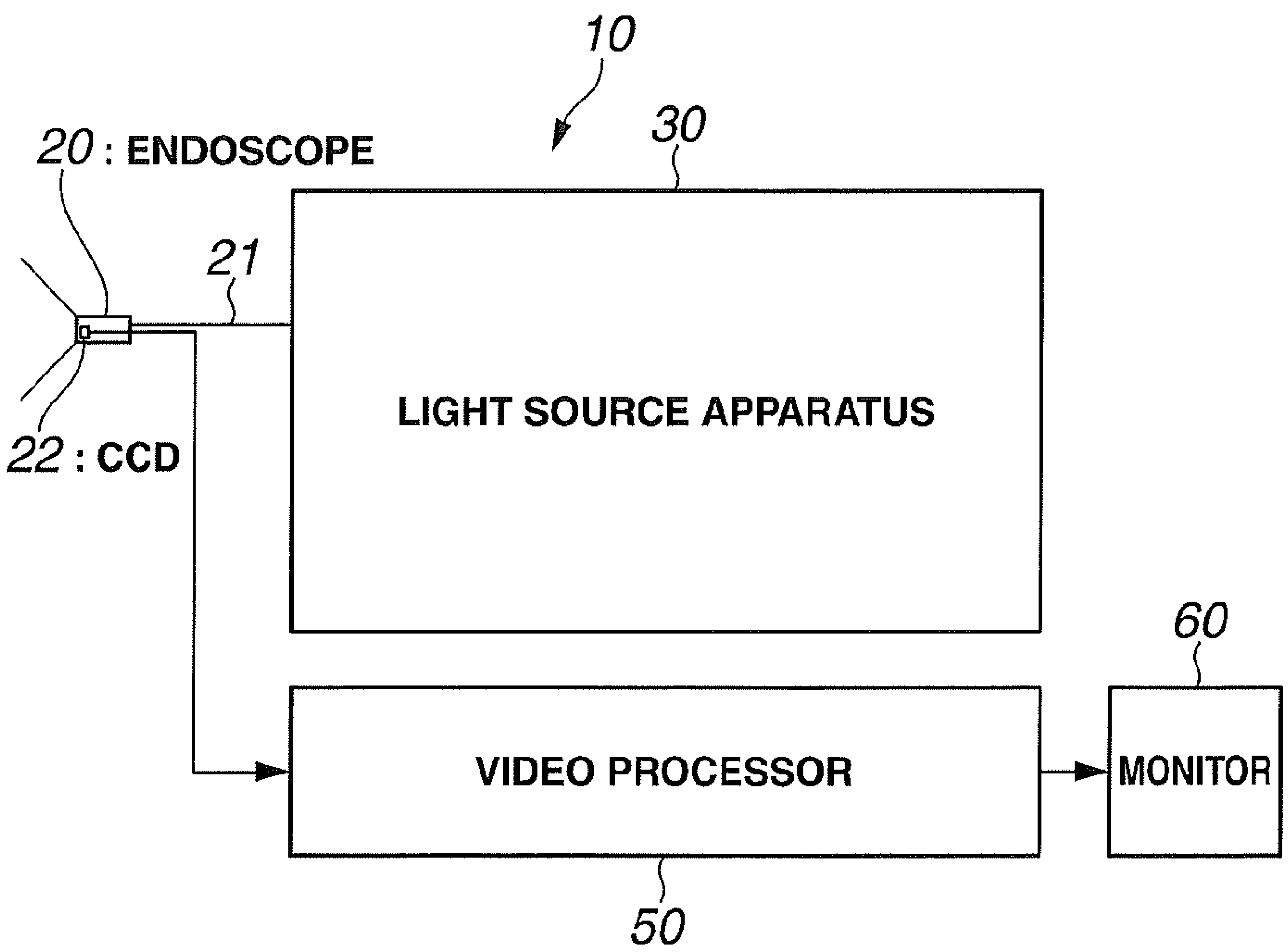

10
30
20 : ENDOSCOPE
21
22 : CCD
LIGHT SOURCE APPARATUS
60
VIDEO PROCESSOR
MONITOR
50

FIG.2

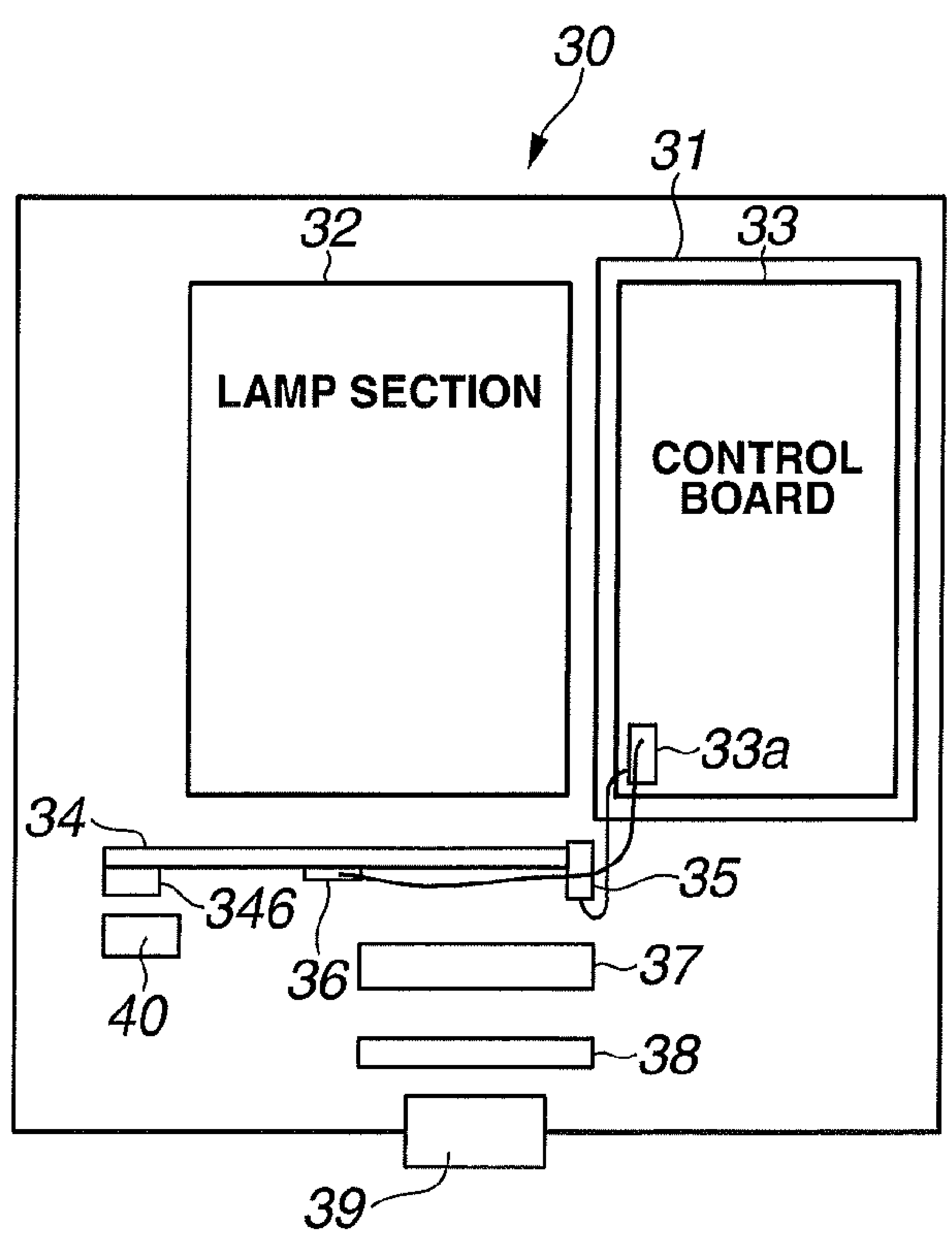

30
31
32
33
LAMP SECTION
CONTROL BOARD
33a
34
35
346
36
37
40
38
39

FIG.3A

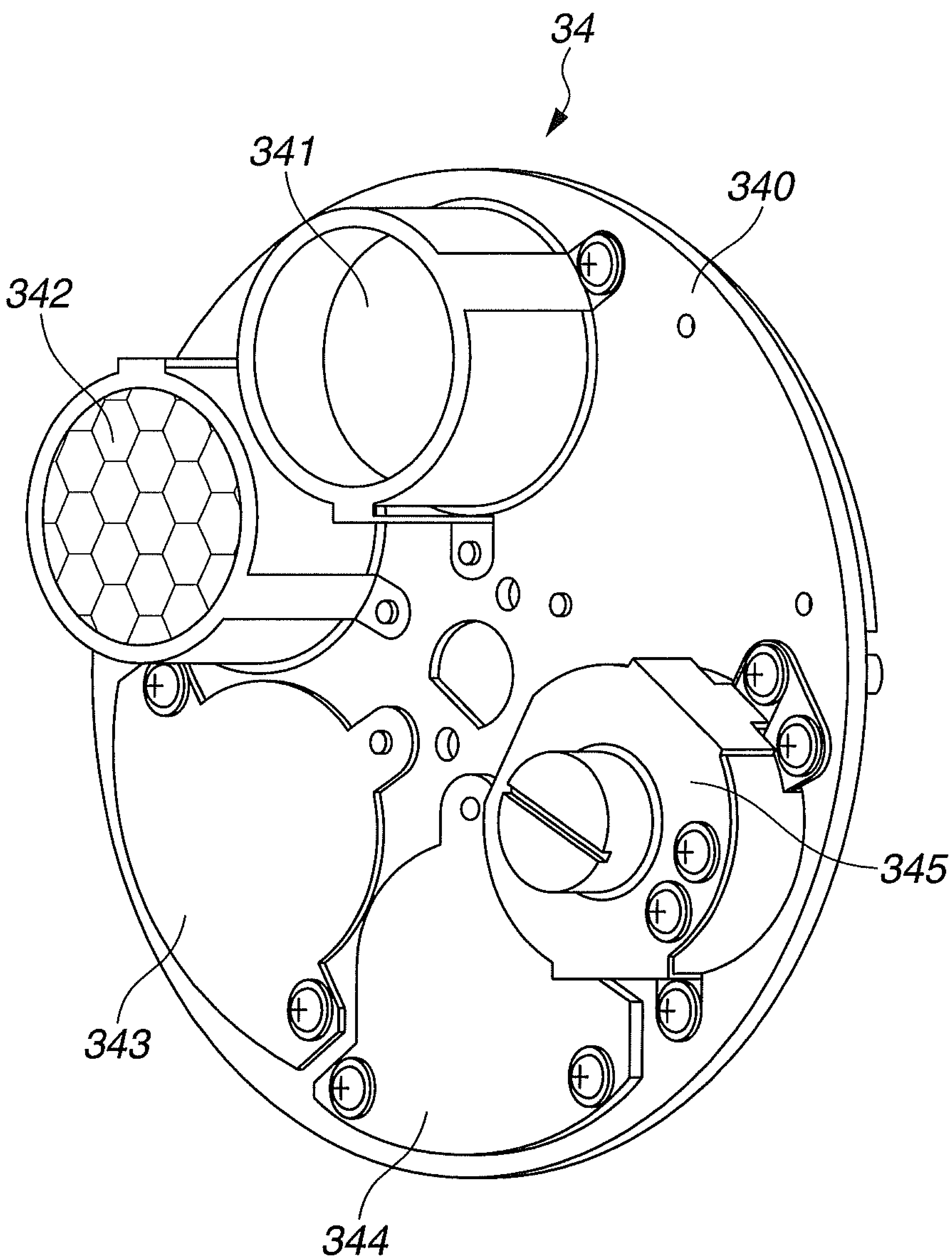


FIG.3B

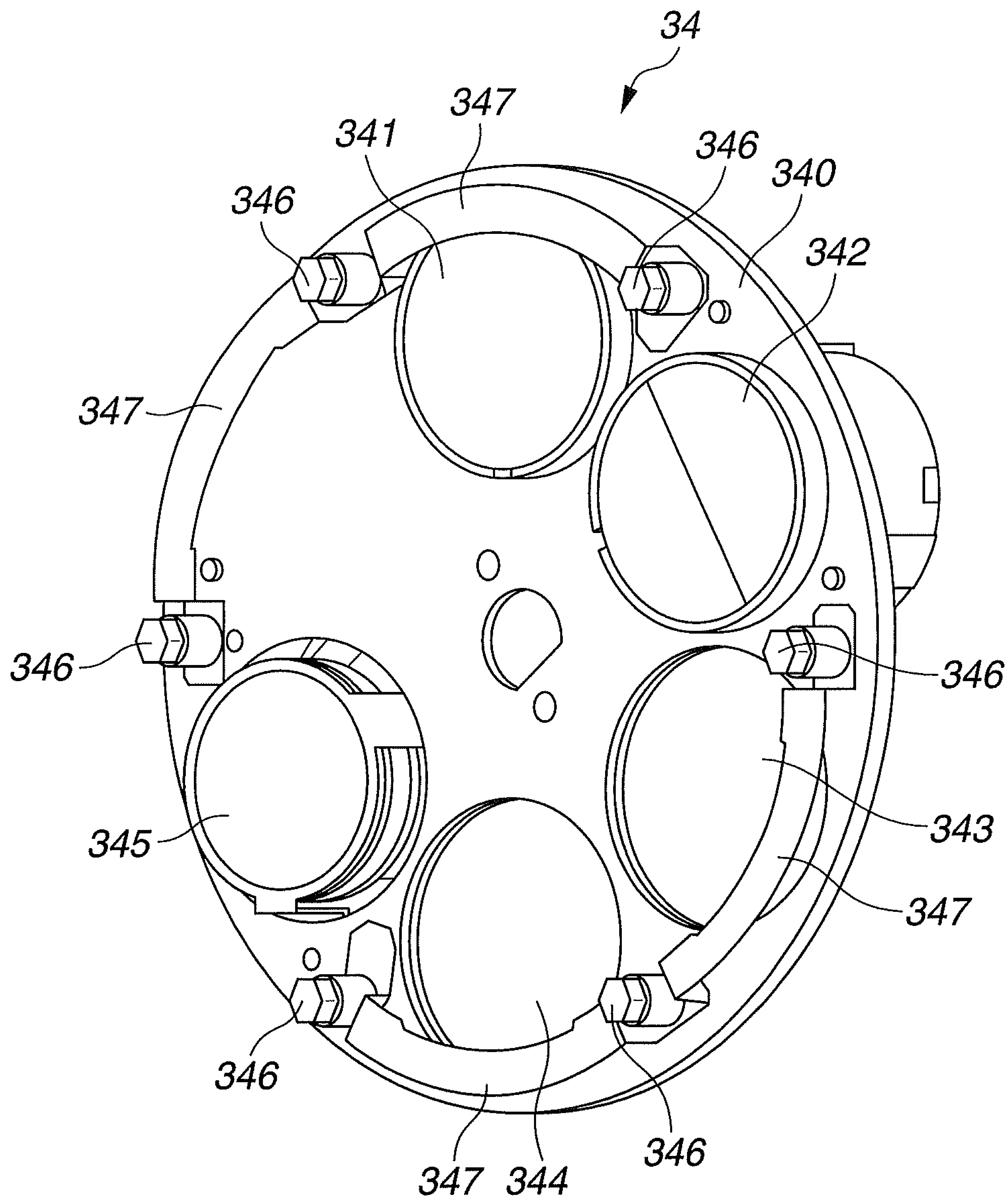

34
347
341
346
346
340
342
347
346
346
345
343
347
346
346
347
344

FIG.4

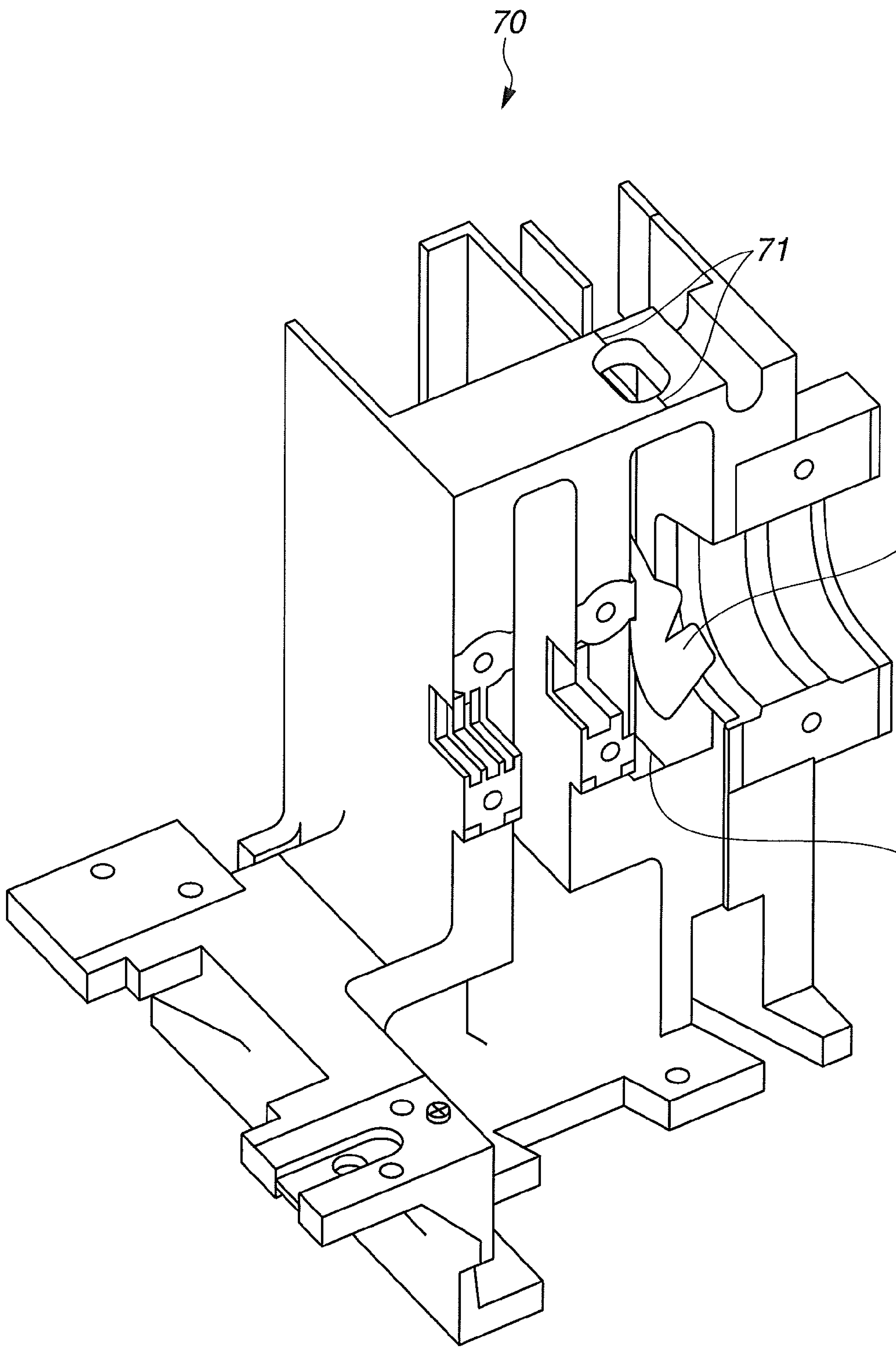


FIG.5

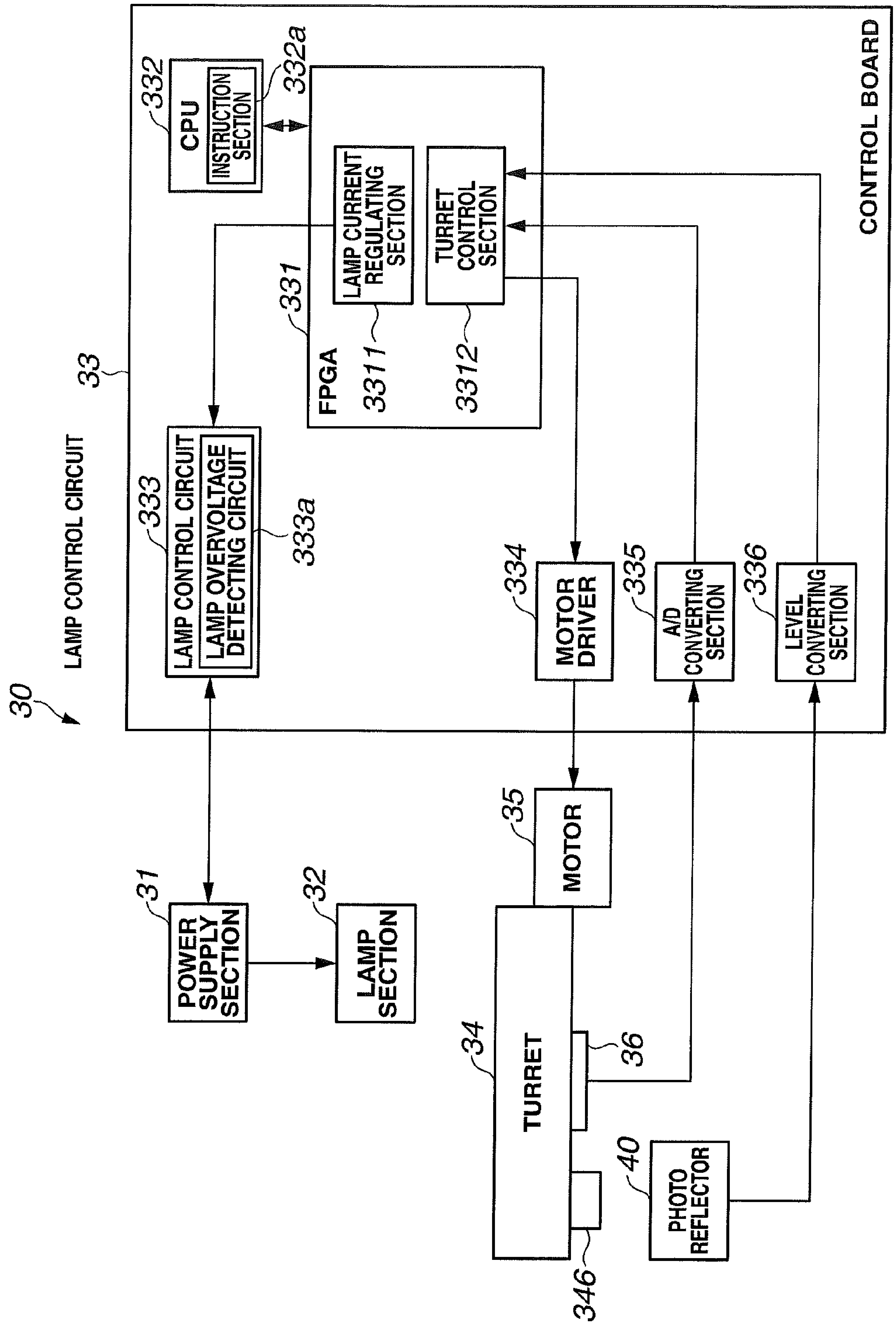

30
LAMP CONTROL CIRCUIT
33
CONTROL BOARD
332
CPU
INSTRUCTION SECTION
332a
331
FPGA
LAMP CURRENT REGULATING SECTION
3311
TURRET CONTROL SECTION
3312
333
LAMP CONTROL CIRCUIT
LAMP OVERVOLTAGE DETECTING CIRCUIT
333a
334
MOTOR DRIVER
335
A/D CONVERTING SECTION
336
LEVEL CONVERTING SECTION
31
POWER SUPPLY SECTION
32
LAMP SECTION
35
MOTOR
34
TURRET
36
346
40
PHOTO REFLECTOR

FIG.6

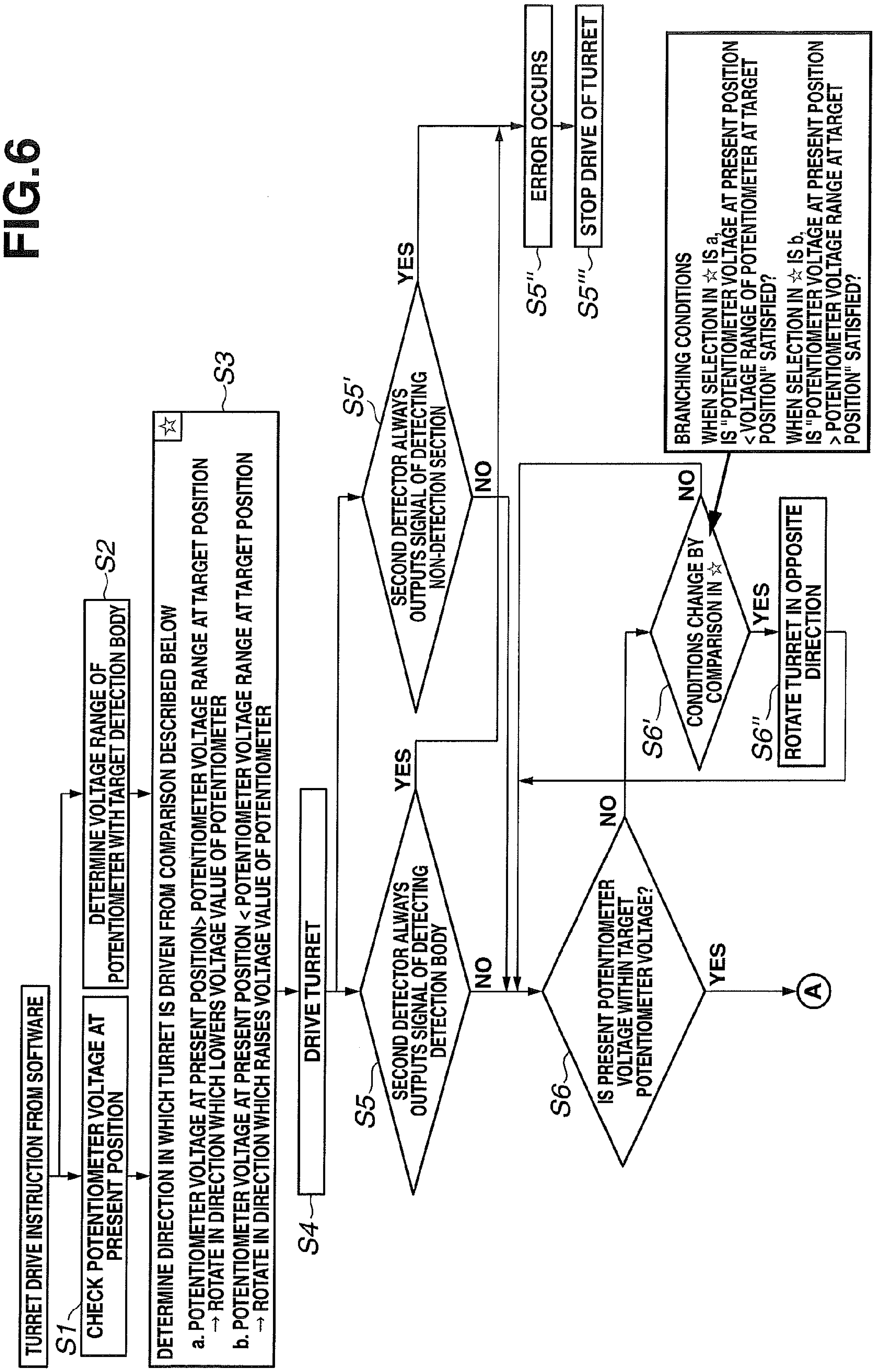

TURRET DRIVE INSTRUCTION FROM SOFTWARE
S1
CHECK POTENTIOMETER VOLTAGE AT PRESENT POSITION
S2
DETERMINE VOLTAGE RANGE OF POTENTIOMETER WITH TARGET DETECTION BODY
S3
DETERMINE DIRECTION IN WHICH TURRET IS DRIVEN FROM COMPARISON DESCRIBED BELOW
a. POTENTIOMETER VOLTAGE AT PRESENT POSITION> POTENTIOMETER VOLTAGE RANGE AT TARGET POSITION
→ ROTATE IN DIRECTION WHICH LOWERS VOLTAGE VALUE OF POTENTIOMETER
b. POTENTIOMETER VOLTAGE AT PRESENT POSITION < POTENTIOMETER VOLTAGE RANGE AT TARGET POSITION
→ ROTATE IN DIRECTION WHICH RAISES VOLTAGE VALUE OF POTENTIOMETER
☆
S4
DRIVE TURRET
S5
SECOND DETECTOR ALWAYS OUTPUTS SIGNAL OF DETECTING DETECTION BODY
YES
NO
S5'
SECOND DETECTOR ALWAYS OUTPUTS SIGNAL OF DETECTING NON-DETECTION SECTION
YES
NO
S5''
ERROR OCCURS
S5'''
STOP DRIVE OF TURRET
S6
IS PRESENT POTENTIOMETER VOLTAGE WITHIN TARGET POTENTIOMETER VOLTAGE?
YES
NO
A
S6'
CONDITIONS CHANGE BY COMPARISON IN ☆
YES
NO
S6''
ROTATE TURRET IN OPPOSITE DIRECTION
BRANCHING CONDITIONS
WHEN SELECTION IN ☆ IS a, IS "POTENTIOMETER VOLTAGE AT PRESENT POSITION <VOLTAGE RANGE OF POTENTIOMETER AT TARGET POSITION" SATISFIED?
WHEN SELECTION IN ☆ IS b, IS "POTENTIOMETER VOLTAGE AT PRESENT POSITION >POTENTIOMETER VOLTAGE RANGE AT TARGET POSITION" SATISFIED?

FIG.7

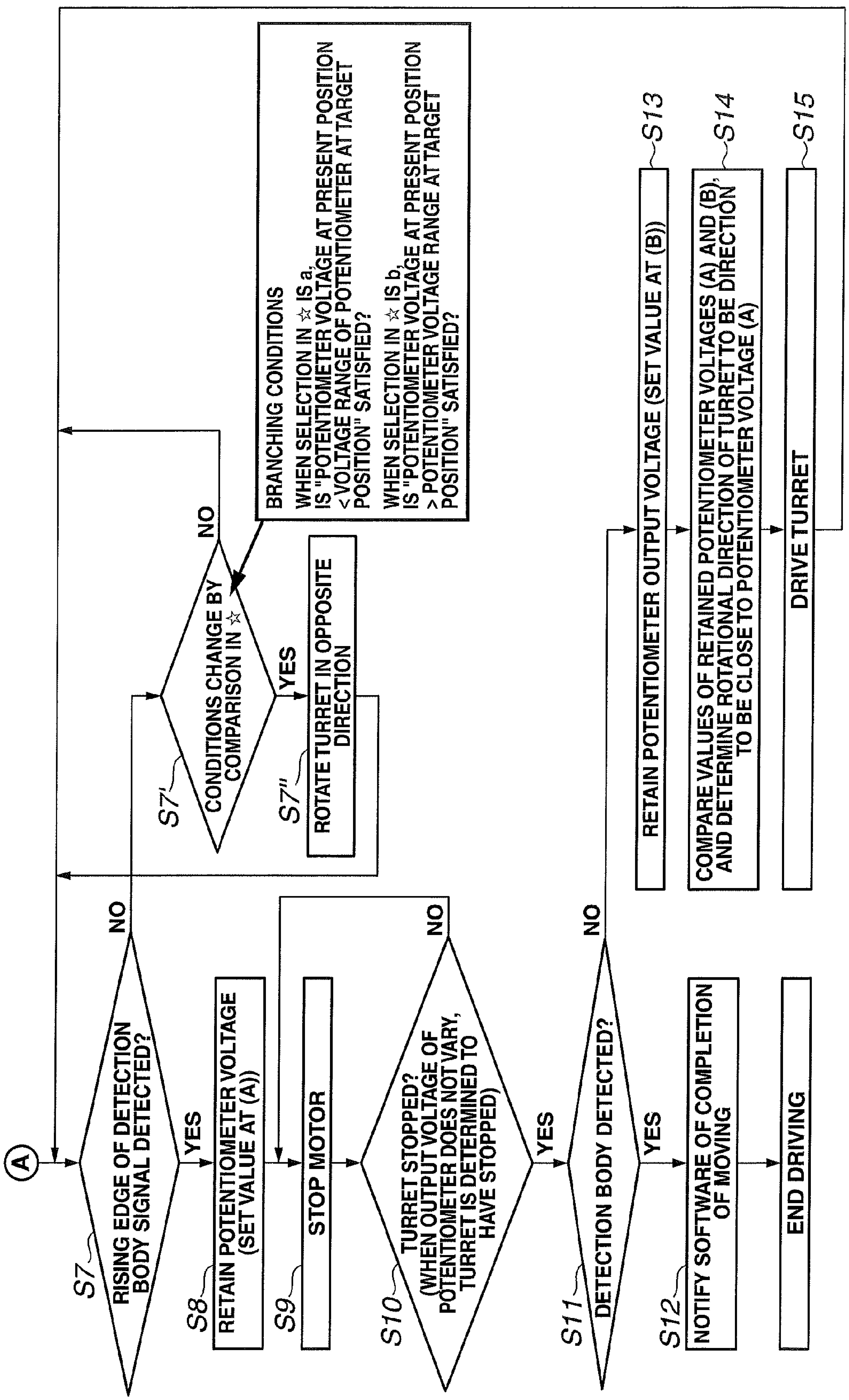

A
S7
RISING EDGE OF DETECTION BODY SIGNAL DETECTED?
YES
NO
S7'
CONDITIONS CHANGE BY COMPARISON IN ☆
YES
NO
S7''
ROTATE TURRET IN OPPOSITE DIRECTION
BRANCHING CONDITIONS
WHEN SELECTION IN ☆ IS a, IS "POTENTIOMETER VOLTAGE AT PRESENT POSITION < VOLTAGE RANGE OF POTENTIOMETER AT TARGET POSITION" SATISFIED?
WHEN SELECTION IN ☆ IS b, IS "POTENTIOMETER VOLTAGE AT PRESENT POSITION > POTENTIOMETER VOLTAGE RANGE AT TARGET POSITION" SATISFIED?
S8
RETAIN POTENTIOMETER VOLTAGE (SET VALUE AT (A))
S9
STOP MOTOR
S10
TURRET STOPPED? (WHEN OUTPUT VOLTAGE OF POTENTIOMETER DOES NOT VARY, TURRET IS DETERMINED TO HAVE STOPPED)
YES
NO
S11
DETECTION BODY DETECTED?
YES
NO
S12
NOTIFY SOFTWARE OF COMPLETION OF MOVING
END DRIVING
S13
RETAIN POTENTIOMETER OUTPUT VOLTAGE (SET VALUE AT (B))
S14
COMPARE VALUES OF RETAINED POTENTIOMETER VOLTAGES (A) AND (B), AND DETERMINE ROTATIONAL DIRECTION OF TURRET TO BE DIRECTION TO BE CLOSE TO POTENTIOMETER VOLTAGE (A)
S15
DRIVE TURRET

FIG.8

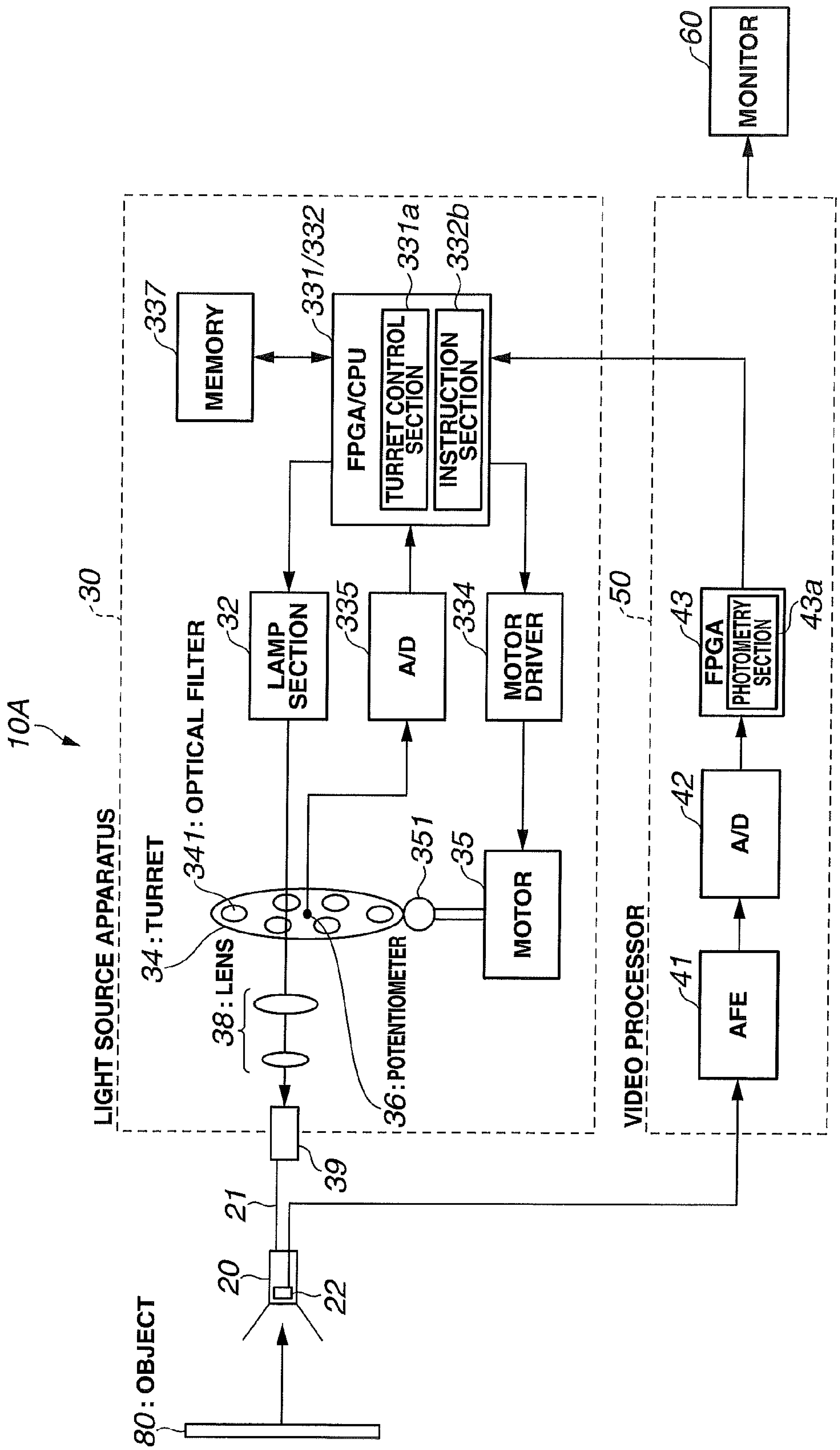
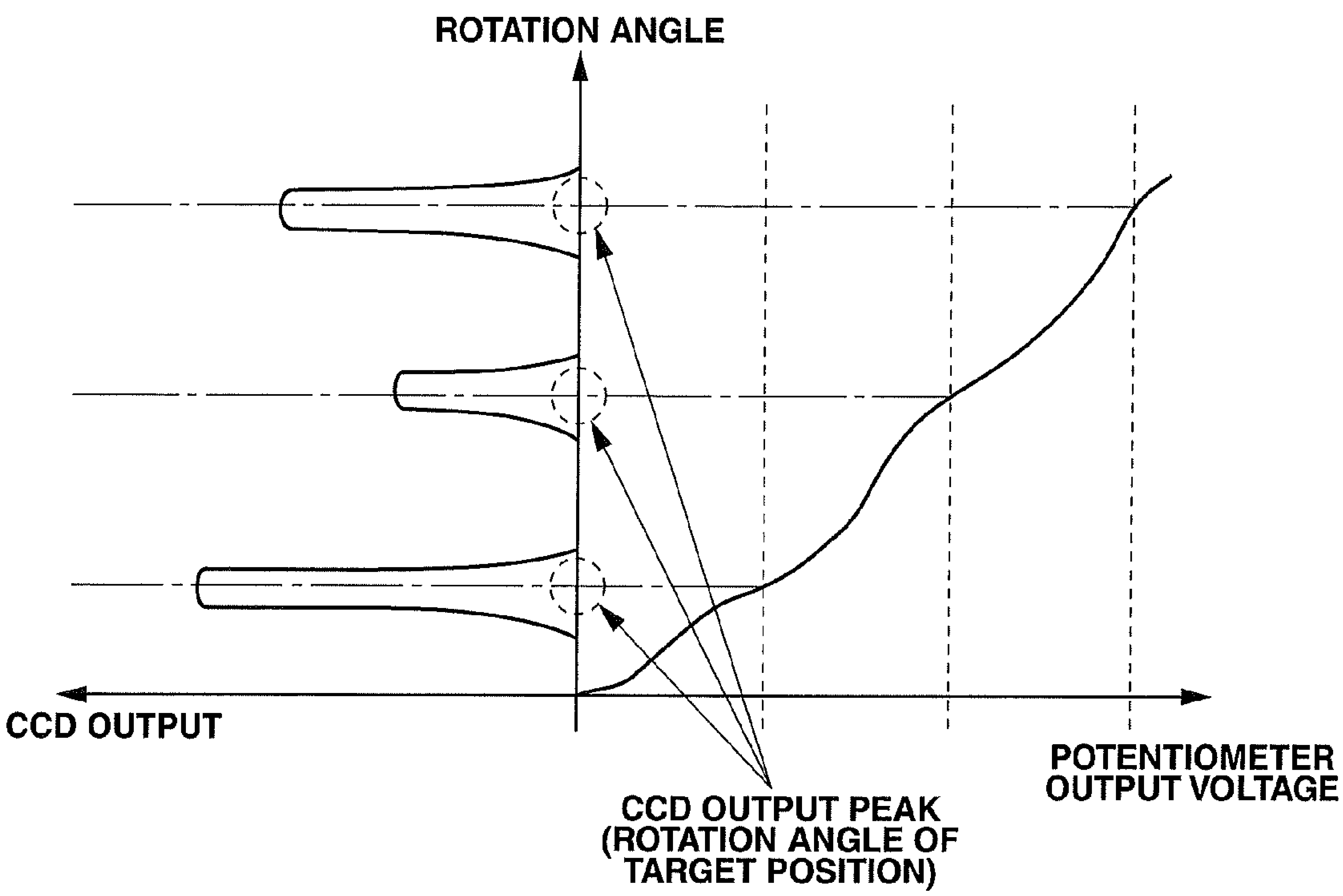

10A
30
LIGHT SOURCE APPARATUS
34 : TURRET
341 : OPTICAL FILTER
38 : LENS
36 : POTENTIOMETER
351
35
MOTOR
32
LAMP SECTION
335
A/D
334
MOTOR DRIVER
337
MEMORY
331/332
FPGA/CPU
331a
TURRET CONTROL SECTION
332b
INSTRUCTION SECTION
39
21
20
22
80 : OBJECT
50
VIDEO PROCESSOR
41
AFE
42
A/D
43
FPGA
PHOTOMETRY SECTION
43a
60
MONITOR

FIG.9


ROTATION ANGLE
CCD OUTPUT
POTENTIOMETER OUTPUT VOLTAGE
CCD OUTPUT PEAK (ROTATION ANGLE OF TARGET POSITION)

ENDOSCOPE LIGHT SOURCE APPARATUS AND ENDOSCOPE SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation application of PCT/JP2011/065983 filed on Jul. 13, 2011 and claims benefit of Japanese Application No. 2010-159953 filed in Japan on Jul. 14, 2010, the entire contents of which are incorporated herein by this reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an endoscope light source apparatus and an endoscope system, and more particularly to an endoscope light source apparatus that controls a turret provided with an optical filter for transmitting an illuminating light, and an endoscope system that picks up an image of an object by the illuminating light that passes through the turret.

2. Description of the Related Art

When inspection/observation or treatment is performed with use of an endoscope, a light source apparatus that emits an illuminating light, a video processor that processes an endoscopic image of an inspected site picked up by an image pickup device at an endoscope distal end, and a monitor that displays the processed endoscopic image are needed.

In a conventional light source apparatus for an endoscope, a plurality of filters are prepared and selection is made from the filters for use to adjust a light amount, a color tone and the like to a proper light amount, a proper color tone and the like in accordance with a kind of a body cavity to be observed, exposure at a time of photographing, a light amount of a light source lamp and the like. Further, an emergency light which is used in place of the light source lamp when the light source lamp fails during use of the light source lamp is also prepared.

The various filters and the emergency light are disposed at a circumferential portion of a turret, which is rotatably provided, along a circumferential direction thereof. The above-described turret is rotated, whereby the various filters and the emergency light which are needed are located on an emission light path (refer to, for example, Japanese Patent Application Laid-Open Publication No. 2001-343595).

The conventional turret includes a motor for rotating the turret, and a potentiometer mounted to a rotary shaft to detect a rotational angle of the turret.

In order to locate the filter corresponding to a use purpose on the emission light path out of a plurality of filters on the turret, it is necessary to correctly match a center of the target filter with an optical axis of the emission light by rotating the turret by a required angle.

SUMMARY OF THE INVENTION

An endoscope light source apparatus of one aspect of the present invention includes a turret provided with a first optical filter and a second optical filter for transmitting an illuminating light, an instruction section in which an operation instruction of the turret is inputted, a drive section that drives the turret, a first detector that detects a position of the turret, a first detected portion for identifying a position of the first optical filter, a second detected portion for identifying a position of the second optical filter, a second detector that optically detects a position of the first or the second detected portion, and a turret control section that outputs a drive signal to the drive section to move the turret until the first or the second detected portion is detected by the second detector in order to position the optical filter designated in response to an input of the instruction section, after moving the turret to an inside of a first range detected by the first detector, in response to the input of the instruction section, and stop the turret in response to the first or the second detected portion being detected.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing an endoscope system according to the present invention;

FIG. **2** is a plan view showing a structure of an endoscope light source apparatus interior of a first embodiment of the present invention;

FIG. **3**A is a perspective view showing a structure of a turret at an incident side;

FIG. **3**B is a perspective view showing a structure of the turret at an exit side;

FIG. **4** is a perspective view showing a position adjustment structure that is used at a time of assembly of diaphragm blades;

FIG. **5** is an electric control block diagram of a light source apparatus;

FIG. **6** is a flowchart of a control operation;

FIG. **7** is a flowchart of a control operation;

FIG. **8** is a block diagram showing an endoscope system of a second embodiment of the present invention; and

FIG. **9** is a diagram showing a relation of a CCD signal output, a turret rotational angle and a potentiometer voltage.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

FIG. **1** is a block diagram showing an endoscope system according to the present invention.

In FIG. **1**, an endoscope system **10** includes an endoscope **20** that includes a light guide **21** that guides an illuminating light to a distal end portion and a CCD **22** as an image pickup device that performs image pickup of a subject, a light source apparatus **30** that emits light to the light guide that supplies the illuminating light to an endoscope distal end portion, a video processor **50** that processes an endoscope image of an inspected site that is picked up by the CCD **22** at the endoscope distal end portion, and a monitor **60** that displays the processed endoscopic image.

First Embodiment

FIG. **2** is a plan view showing a structure of an endoscope light source apparatus interior of a first embodiment of the present invention. FIG. **2** corresponds to an interior structure of the light source apparatus **30** in FIG. **1**.

In FIG. **2**, the light source apparatus **30** includes a power supply section **31** that supplies electric power to respective sections in the light source apparatus **30**, a lamp section **32** that supplies an illuminating light to the light guide of the endoscope **20**, a control board **33** that includes an input/output terminal **33***a* that outputs a motor drive signal to a turret **34**, and receives a potentiometer detection signal from the turret **34**, and includes instruction means that gives an operation instruction to the turret **34** and turret control means that controls the turret **34**, the turret **34** that includes an optical filter (hereinafter, sometimes simply called a filter) that transmits a light from a lamp from the lamp section **32**, a motor **35** as drive means that rotationally drives the turret **34**, a potentiometer **36** as a first detector that detects the rotation angle as a position of the turret **34**, a lens **37** for converging an emission light, a diaphragm **38** for adjusting a light amount of the emission light, a scope insertion port **39** to which the light guide which is light guide means of an insertion portion of the endoscope (scope) is connected, and a photo reflector **40** as a second detector that detects a position in a range narrower than a range that is detected with the potentiometer **36** that is the first detector. Note that the lamp section **32** is shown in a state in which the lamp section **32** is placed by being overlaid on the power supply section **31**.

FIG. **3**A and FIG. **3**B are perspective views showing a structure of the turret **34**, FIG. **3**A shows a perspective view of the turret **34** seen from an incident side, and FIG. **3**B shows a perspective view of the turret **34** seen from an exit side respectively.

On the incident side of the turret **34**, cylindrical frame bodies provided with optical filters **341** and **342** respectively are mounted to an incident side plane of a filter disk **340** with screws as shown in FIG. **3**A. Further, a back surface side of an emergency light **345** is mounted to the incident side plane of the filter disk **340** with screws by using a mounting frame. Further, to the incident side plane of the filter disk **340**, optical path shielding plates **343** and **344** are fastened with screws in such a manner as to close circular optical filter mounting hole portions (holes for use in the case of new optical filters being added) from the incident side, with respect to the circular optical filter mounting hole portions.

Note that if the optical filter is not installed on the turret **34**, the portion corresponding thereto needs to be shielded with an optical path shielding plate as a mask. If the two optical path shielding plates **344** and **343** are not present in FIG. **3**A, three regions where optical filters can be placed are vacant, and the mass balance on the filter disk **340** is lost, as a result of which, excessive load is exerted on the turret rotating motor **35**, but if suitable masses are given to the optical path shielding plates **344** and **343**, the mass balance can be substantially restored by the optical path shielding plates **344** and **343** being placed in the two optical filter vacant regions of the filter disk **340**. Furthermore, when the optical path shielding plates **344** and **343** are removed from the state of FIG. **3**A, and two of new optical filters are mounted on the two vacant optical filter regions, one of the optical path shielding plates **344** and **343** that is suitable from the viewpoint of mass out of the optical path shielding plates **344** and **343** which are removed in advance is placed on the vacant region (region where the hole is not provided) at an upper right side of FIG. **3**A, whereby the mass balance can be kept more properly.

On the exit side of the turret **34**, fitting portions of the optical filters **341** and **342** are mounted to an emission side plane of the filter disk **340** to be projected to some degree as shown in FIG. **3**B. Further, a light emission side of the emergency light **345** is mounted to the emission side plane of the filter disk **340** to be projected with the highest height. Furthermore, it is shown that on the emission side plane of the filter disk **340**, the above-described optical path shielding plates **343** and **344** block the circular optical filter mounting hole portions. In addition, on the emission side plane of the filter disk **340**, six columnar detection bodies **346** the number of which is the same as the number of a plurality of (six in the drawing) optical filter regions which can be placed in a circumferential direction of an outer edge of the turret **34** are projectingly provided. The plurality of columnar detection bodies **346** are formed so that all heights thereof are the same heights, and the heights of the respective detection bodies **346** are formed to be such heights that exceed the maximum value of the heights of the plurality of projected portions which appear on the emission side of the turret **34**. It is necessary that the plurality of columnar detection bodies **346** receive light from the photo reflector **40** (refer to FIG. **5**) which will be described later, reflect the light on detection bodies distal end surfaces thereof, and thereby enabling the photo reflector **40** to receive the reflected light thereof and reliably perform positional detection. Accordingly, in the filter plane **340** of the turret **34**, regions other than the distal end surfaces of the plurality of columnar detection bodies **346** are preferably coated with an irreflective member (for example, a black color coating material) which does not reflect the light from the photo reflector **40**.

As above, the reference position of the turret is configured by the columnar detection body for each of the respective filters, and therefore, the structure can be realized, in which even if a plurality of projected portions which are projected are present on the surface of the turret, the reference positions can be reliably read with the second detector at low cost.

FIG. **4** shows a structure which applies a measure to be able to realize enhancement of assembly precision and enhancement of assembly operability, in an assembly process of a diaphragm blade **38***a* as light amount control means which is placed on the light emission side of the turret **34** in the light source apparatus **30**. FIG. **4** shows a configuration in which in a support body **70** that rotatably supports the diaphragm blade **38***a*, slits **71** and **72** are provided on a top and a bottom of a mounting portion (recessed place portion) of the diaphragm blade **38***a* which is formed in the support body **70**, and positional adjustment of the diaphragm blade **38***a* is performed in correspondence with the slits **71** and **72** on the top and the bottom. The slits are provided on the top and the bottom of the mounting frame of the diaphragm blade **38***a*, whereby it becomes possible to determine that the positional adjustment of the diaphragm blade **38***a* is favorable when the slits **71** and **72** on the top and the bottom and the diaphragm blade **38***a* are aligned in one straight line when the slits **71** and **72** and the diaphragm blade **38***a* are seen from directly above. Thereby, enhancement of the assembly precision and the assembly operability of the diaphragm blade can be realized.

FIG. **5** shows an electric control block diagram of the light source apparatus **30**. The same sections as the sections in FIG. **2** are assigned with the same reference signs.

In FIG. **5**, the light source apparatus **30** includes the power supply section **31**, the lamp section **32**, the control board **33**, the turret **34**, the motor **35**, the potentiometer **36**, the detection bodies **346** and the photo reflector **40**.

The potentiometer **36** is mounted to a rotary shaft of the turret **34**, and an output signal thereof is sent to the control board **33**. The photo reflector **40** detects the detection body **346** which is disposed at each of the optical filters, and an output signal thereof is sent to the control board **33**.

An angle of the turret **34** at which the photo reflector **40** detects the detection body **346**, and an angle of the turret **34** at which the optical filter enters the optical path are the same.

The detection body **346** which the photo reflector **40** detects is placed at each of the optical filters, which enters the optical path. Therefore, it is determined that for each of the optical filters, in the case of which angle, detection of the detection body **346** is performed, and the turret angles at which the six detection bodies **346** (refer to FIG. **3**B) are present, that is, the angles at which the six optical filters enter the optical path increase by 60° from an angle at the time of start of rotation.

The control board **33** includes a FPGA (abbreviation of field programmable gate array) **331** including a lamp current regulating section **3311** and a turret control section **3312**, a CPU **332** including an instruction section **332***a* as instruction means that gives an operation instruction to the turret **34**, a lamp control circuit **333** including a lamp overvoltage detecting circuit **333***a*, a motor driver **334** of the motor **35**, an A/D converting section **335** that A/D-converts a detection signal of the potentiometer **36**, and a level converting section **336** that converts a level of a detection signal of the photo reflector **40**.

The lamp current regulating section **3311** provided in the FPGA **331** switches an observation light mode and at the same time, switches a lamp current in the lamp current regulating section **3311** when endoscope observation is performed with an observation light of a different wavelength, whereby observation of a bright image is always enabled. For example, when a normal light observation mode by a white light (WL) and a special light observation mode by a narrow band light (NBI) are available, brightness on the monitor is very low at the time of NBI observation as compared with the WL observation. In contrast with this, the brightness on the monitor is conventionally gained by an electric gain (AGC) being increased, but noise also increases, and therefore, S/N becomes worse at the time of NBI observation. Therefore, at the time of NBI, input power (voltage, current) to the lamp is increased more than at the time of WL, whereby the brightness of the image on the monitor can be increased without noise being increased.

The turret control section **3312** provided in the FPGA **331** outputs a drive signal to the motor **35** that is drive means so as to move the turret **34** to an inside of a second range which is narrower than an inside of a first range and is detected by the photo reflector **40** that is a second detector after moving the turret **34** to the inside of the first range detected by the potentiometer **36**, based on the outputs from the aforementioned instruction section **332***a* as the instruction means, and the potentiometer **36** that is a first detector.

As above, a drive signal of the motor **35** is controlled with the turret control signal from the turret control section **3312**. A rough angle of the turret **34** is detected with the potentiometer that is the first detector, and detailed position detection of the turret **34** can be performed with the second detector, and improvement of the turret stop position precision can be realized.

The lamp control circuit **333** includes the lamp overvoltage detecting circuit **333***a*. The lamp overvoltage detecting circuit **333***a* is a circuit for turning off the lamp when a lamp of the lamp section **32** fails and is brought into a state in which an overvoltage occurs to the lamp, and turns off the lamp when the voltage exceeds a threshold value by providing the threshold value at the lamp voltage. Thereby, a patient can be prevented from getting scalded by the lamp failing to cause an excessive current of a rated current or more to flow and the lamp having an excessive light amount.

FIG. **6** and FIG. **7** are flowcharts of a control operation. Note that FIG. **6** and FIG. **7** are of one flowchart, but expressed as two diagrams because of the paper space.

A control method will be described with reference to FIG. **6** and FIG. **7**.

In step S**1**, in the control board **33**, when hardware receives a drive command of the turret **34** regarding a target position from software, the output voltage of the potentiometer **36** at the present position is detected.

In step S**2**, an output voltage range of the potentiometer **36** for allowing the optical filter at the target position to enter the optical path held by the hardware in advance is called.

In step S**3**, the results of steps S**1** and S**2** are obtained, the output voltage of the potentiometer **36** at the present position and the output voltage range for causing the optical filter of the target position to enter the optical path are compared with each other, and a drive direction of the motor **35** is determined.

a. Potentiometer voltage at the present position>potentiometer voltage range of the target position ⇒ rotates in the direction which lowers the voltage value of the potentiometer

b. Potentiometer voltage at the present position<potentiometer voltage range of the target position ⇒ rotates in the direction which raises the voltage value of the potentiometer

In step S**4**, the motor **35** is driven, and the turret **34** is rotated.

In step S**5**, it is determined whether or not the photo reflector **40** which is the second detector always outputs the signal indicating that the photo reflector **40** detects the detection body **346**. Further, in step S**5**', it is determined whether or not the photo reflector **40** always outputs the signal indicating that the photo reflector **40** detects non-detection section (region coated with the irreflective member).

When in any one of steps S**5** and S**5**', the signal detecting the detection body or non-detection section is always outputted, it is determined that an error occurs (step S**5**"), and drive of the turret **34** is stopped (step S**5**'").

In step S**6**, it is found out whether the current potentiometer output voltage is in the target potentiometer output voltage range.

When the current potentiometer output voltage is within the target voltage range, the flow proceeds to step S**7**.

When the current potentiometer output voltage is outside the target voltage range, the flow proceeds to step S**6**', and from the comparison result in step S**3**, it is determined whether the turret **34** is rotated as it is, or rotated in the opposite direction.

When the comparison result in step S**3** is a, the turret **34** is rotated in a direction which lowers the potentiometer voltage, but when "potentiometer voltage at the present position<the potentiometer voltage range of the target position" is satisfied, the turret **34** is excessively rotated, and therefore, the turret **34** is rotated in the opposite direction as shown in step S**6**." Otherwise, the turret **34** is rotated as it is.

When the comparison result in step S**3** is b, the turret **34** is rotated in a direction which raises the potentiometer voltage, but when "potentiometer voltage at the present position>potentiometer voltage range of the target position" is satisfied, the turret is excessively rotated, and therefore, the turret is rotated in the opposite direction as shown in step S**6**." Otherwise, the turret is rotated as it is.

In step S**7**, in order to find out that the photo reflector **40** detects the detection body **346**, a rising edge of a photo reflector output signal at a time of the detection body **346** being detected is detected.

When the rising edge is detected, the flow proceeds to step S**8**.

When the rising edge is not detected, the flow proceeds to step S**7**', and from the comparison result in step S**3**, it is determined whether the turret **34** is rotated as it is, or rotated in the opposite direction.

When the comparison result in step S**3** is a, the turret **34** is rotated in the direction which lowers the potentiometer voltage, but when "potentiometer voltage at the present position<potentiometer voltage range of the target position" is satisfied, the detection body **346** is not detected, and therefore, the turret **34** is rotated in the opposite direction as shown in step S**7**," whereby detection of the

detection body **346** is performed. Otherwise, the turret **34** is rotated as it is, and detection of the detection body **346** is continued.

When the comparison result in step S**3** is b, the turret **34** is rotated in the direction which raises the potentiometer voltage, but when "potentiometer voltage at the present position>potentiometer voltage range of the target position" is satisfied, the detection body **346** is not detected, and therefore, the turret is rotated in the opposite direction as shown in step S**7**," whereby detection of the detection body **346** is performed. Otherwise, the turret **34** is rotated as it is, and detection of the detection body **346** is continued.

In step S**8**, the output voltage value of the potentiometer **34** at the time of the rising edge of the photo reflector output signal being detected is retained. The retained value is set as (A).

In step S**9**, a control signal that stops the motor **35** is sent.

In step S**10**, even after the control signal that stops the motor **5** is sent, the turret **34** also rotates as the motor **5** rotates by inertia, and therefore, in order to find out that rotation of the turret **34** completely stops, it is found out that there is no variation of the output voltage value of the potentiometer **36**.

In step S**11**, there is the possibility that the photo reflector **40** does not detect the detection body **346** due to the influence of the rotation by the inertia of the motor **34** of step S**10** when the rotation of the turret **34** stops, and therefore, it is ascertained that the photo reflector **40** detects the detection body **346**.

When the photo reflector **40** detects the detection body **346**, the flow proceeds to step S**12**.

When the photo reflector **40** does not detect the detection body **346**, the flow proceeds to step S**13**, the potentiometer output voltage at the time is retained, and a value thereof is set as (B).

The potentiometer output voltage (A) retained in step S**8** and the current potentiometer output voltage (B) are compared, and if the current potentiometer output voltage overruns, the rotational direction of the turret is determined to be the direction to approach the potentiometer output voltage value (A) (step S**14**). The turret **34** is rotationally driven in step S**15**.

In step S**12**, the drive of the turret **34** is completed, and therefore, the software is notified of the completion of the movement, and the drive of the turret **34** is completed.

Note that the second detector may be an optical sensor such as a photo interrupter, besides the photo reflector **40**. In the case of the photo interrupter, drive of the motor **35** can be stopped when a matter which blocks the optical path between the LED and the sensor enters.

The detection body **346** may be either a reflective body or an irreflective body, and the user can make choice.

When the photo reflector **40** is used, a sheet metal portion with a high reflectivity and a silk portion with a low reflectivity are inverted and an area of the silk portion is made large, so that the LED light emission of the photo reflector does not become disturbance noise to other photo reflectors, whereby the influence of the disturbance noise is suppressed.

According to the first embodiment, when control of the rotation angle of the turret is performed, the rough angle is detected with the potentiometer that is the first detector, and the detailed positional detection can be performed with the second detector. The detailed positional detection of the rotation angle is performed at the position apart from a center, whereby detection with higher precision than a substantially center of the turret can be performed even when the detection precision is equivalent. Furthermore, when the rotation control of the turret is to be performed with only the second detector, the second detectors the number of which corresponds to the number of the detection positions are required in the outer circumferential direction of the turret, the cost increases and the size also increases, whereas in the present first embodiment, by combination with the first detector, improvement of the turret stop position precision is realized, and the stop precision of the turret can be enhanced at low cost with a relatively simple system.

Second Embodiment

FIG. **8** is a diagram showing an endoscope system of a second embodiment of the present invention.

In FIG. **8**, an endoscope system **10**A includes the endoscope **20** including the light guide **21** as light guide means that guides an illuminating light to the distal end portion and the CCD **22** as the image pickup device that picks up an image of a reflected light image from an object **80**, the light source apparatus **30** that emits light to the light guide **21** that guides the illuminating light to the endoscope distal end portion, the video processor **50** which performs signal processing of an endoscopic image picked up with the CCD **22** at the endoscope distal end portion, the monitor **60** that displays the endoscopic image which is subjected to signal processing, and a power supply section (not illustrated). In the second embodiment of FIG. **8**, the second detector shown in the first embodiment is not required.

The light source apparatus **30** includes the FPGA **331** and the CPU **332**, the lamp section **32**, the turret **34** including the optical filter **341**, the motor **35** as the drive means including a gear **351**, the potentiometer **36** as the detector that detects the position of the turret **34**, the motor driver **334** that drives the motor **35**, the A/D convertor **335** that A/D-converts the output of the potentiometer **36**, a memory **337** as storage means that stores information for driving the turret **34**, and the scope insertion port **39**.

The above described FPGA **331** and CPU **332** include an instruction section **332***b* as instruction means that performs instruction to cause the memory **337** to store information for driving the turret **34**, and a turret control section **331***a* as turret control means that outputs a drive signal for causing the turret **34** to make one rotation to the motor **35** and stores a detection value from the potentiometer **36** at which a measured value from a photometry section **43***a* as photometry means becomes a maximum value while the turret **34** makes one rotation, into the memory **337** by the instruction of the instruction section **33***b*.

The video processor **50** includes a preamplifier **41**, an A/D convertor **42**, and an FPGA **43** including the photometry section **43***a* as the photometry means that generates a photometric signal from the image pickup signal from the CCD **22** and outputs the photometric signal. The photometry section **43***a* in the FPGA **43** calculates a level of brightness (light output intensity) received by the CCD **22**, and outputs the level of the brightness to the FPGA **331** and the CPU **332** in the light source apparatus **30**.

In the above-described configuration, an output voltage of the potentiometer **36** and the level of the brightness received by the CCD **22** are associated with each other, and a potentiometer voltage at which a brightness peak is present is used as a positioning target value (reference) of the turret **34**.

For association, adjustment steps 1 to 6 as follows are required.

1: The light source apparatus **30**, the video processor **50**, and a white chart as the object **80** are prepared, and the lamp is lit.

2: The turret **34** is rotated at a desired rotational speed from a certain position until all the filters pass through the optical axis (rotation is optional, such as one rotation, a plurality of rotations, and a reverse rotation).

3: The output voltage of the potentiometer **36** at the time of the state of 2 is read, and is taken into the FPGA **331**/CPU **332**.

3': CCD output which is the result of receiving a reflected light from the white chart at the time of the state of 2 is taken into the FPGA **331**/CPU **332** of the light source apparatus **30** as brightness information via the video processor **50**.

4: The relation of the potentiometer output voltage and the brightness information can be calculated from 3 and 3'.

5: If six optical filters are present, the output of the CCD **22** has six brightness peaks, and therefore, the output voltages at the time of output thereof are referred to and stored in the memory **332**.

6: The stored voltages are used as a stop angle reference of the turret **34**, and drive control of the turret **34** is performed with the control method similar to the conventional control method.

Note that the present adjustment steps can be performed during inspection (aging of the lamp and the turret) of the light source apparatus **30**, for example, and therefore, the number of adjustment process steps is not required additionally.

Having the brightness peak means that the filter of the turret comes to the optical axis, and therefore, becomes the reference for positional control.

In place of the CCD, an optical sensor, a power meter or the like may be used.

The peak detection method may be a method which causes the turret to make a plurality of rotations and takes an average value of the number of plurality of rotations and the like, besides the method for taking the peak when the turret makes one rotation.

FIG. **9** is a diagram showing a relation of the CCD signal output, the turret rotation angle and the potentiometer voltage. Before shipment or before use of the light source apparatuses, the potentiometer voltages corresponding to the CCD output peaks (turret rotation angles) are measured and stored in advance in the memory **337** individually for the actual light source apparatuses.

According to the second embodiment, the stop precision of the turret can be enhanced without adoption of a potentiometer with high precision or increase of mechanical precision, and without increase of cost with the light source apparatus and the configuration of the turret in the conventional art being kept.

The present invention is not limited to the embodiments described above, and various modifications, alterations and the like can be made within the range without departing from the gist of the present invention.

What is claimed is:

1. An endoscope light source apparatus, comprising:

a turret provided to be rotatable about a predetermined axis, and provided with a first optical filter and a second optical filter for transmitting an illuminating light on a circumference of the rotation;

an instruction section in which an operation instruction is inputted, the operation instruction being for locating and stopping the first optical filter or the second optical filter provided to the turret on an optical path of the illuminating light;

a drive section that rotationally drives the turret;

a first detector that detects a rotation angle of the turret and outputs a detection signal according to a result of the detection;

a first detected portion for identifying a position of the first optical filter;

a second detected portion for identifying a position of the second optical filter;

a second detector that optically detects a position of the first or the second detected portion; and

a turret control section that outputs a drive signal to the drive section to move the turret until the first or the second detected portion is detected by the second detector in order to position the optical filter designated in response to an input of the instruction section, after moving the turret so that a value of the detection signal detected by the first detector falls within a range set in advance, in response to the input of the instruction section, and stop the turret in response to the first or the second detected portion being detected.

2. The endoscope light source apparatus according to claim **1**, wherein the second detector detects a position of a mark provided in a circumferential direction of an outer edge of the turret.

3. The endoscope light source apparatus according to claim **2**,

wherein the second detector detects an optical reflected light, and

a columnar detected portion exceeding a maximum value of heights of a plurality of projection portions included in the turret is provided, and the detected portion is detected by the second detector.

4. The endoscope light source apparatus according to claim **1**,

wherein the second detector detects an optical reflected light, and

a columnar detected portion exceeding a maximum value of heights of a plurality of projection portions included in the turret is provided, and the detected portion is detected by the second detector.

5. The endoscope light source apparatus according to claim **4**, wherein sections other than the columnar detected portion in the turret are covered with an optical irreflective member.

6. The endoscope light source apparatus according to claim **4**, wherein as many of the columnar detected portions as a number of optical filter regions, a plurality of which can be placed in a circumferential direction of an outer edge of a filter disk of the turret, are projectingly provided on the filter disk.

* * * * *